Editorial

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The future of diagnosis – where are we going?

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The field of diagnosis and our understanding of the diagnostic process have significantly evolved over the last several decades. The process of diagnostic reasoning has taken on central importance, now viewed through the lens of situativity: the individual decision-maker and their environment (context) are inextricably linked [1, 2]. Our understanding of sociocultural theories and cognitive science have also grown and now better explain the phenomena we see in clinical practice. More recently, we have recognized the importance and ubiquity of a team-based approach to diagnosis – with the patient at the center of the process [3]. But where does the field of diagnosis go from here? How do we move from recognizing these factors to actualizing them to help improve diagnostic performance?

We have made important strides in understanding the incidence, prevalence, and factors leading to diagnostic errors, and multiple studies have revealed the role that systems factors and context play in the diagnostic process [4–6]. How do we understand and account for the important role of context and how are interactions between diagnosticians and the clinical environment impacted by feedback on diagnostic performance and technological advances? How can we embrace the ubiquity and importance of diagnostic uncertainty and how can we begin to effectively teach the distinct but related concept of management reasoning? In this special issue of *Diagnosis,* multiple authors attempt to answer these questions, highlighting strategies that can be implemented now to move the field of diagnosis into the future.

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There is much discussion about the deleterious effect that the modern, often chaotic and fragmented, health care system has on the diagnostic process. In this issue, Linzer and colleagues delve into our understanding of the context in which care is delivered in order to inform systems changes towards improving diagnosis [7]. They propose a conceptual model in which a balanced work environment including work pace, control, teamwork, support, and values alignment can minimize cognitive load and interruptions to working memory, long term memory, and retrieval of information previously collected. The authors go on to propose variables that can be measured to promote a balanced work environment. The future of diagnosis includes studying which of these variables most impact (for good or ill) the diagnostic process and what systems interventions can be done to mitigate these impacts.

Though uncertainty is inherent to the diagnostic reasoning process, how to effectively teach learners to acknowledge and manage this uncertainty within the clinical environment is not known. Two articles in this issue present strategies for teaching uncertainty. Jagannath and colleagues introduce the concept of "intellectual streaking" as coined by Bearman and Molloy – "teachers narrating their thought processes through uncertainties, difficulties, and failures in professional practice" – and describe the importance of cognitive apprenticeship, an educational strategy in which teachers consistently externalize their thought process by thinking aloud and highlighting areas of uncertainty [8]. Santhosh and colleagues present specific educational strategies appropriate for different levels of learners across the education continuum including recognition of uncertainty, how to manage uncertainty, how to communicate uncertainty with patients, and how to promote change in culture to normalize uncertainty [9].

Lessons learned from teaching diagnostic reasoning can be applied to another newly emerging area in diagnosis education—management reasoning. As defined by Cook and colleagues, management reasoning is: "the process of making decisions about patient management, including choices about treatment, follow-up visits, further testing, and allocation of limited resources" [10]. Abdoler and colleagues present several strategies to teach management reasoning including management scripts and the "management

pause" [11]. Importantly, the authors also describe the "equity reflection" to promote learner reflection on their management plans through the lens of inequity. Taking the next leap forward in this area, as in all of diagnosis education, requires strong faculty development initiatives and further research on the effectiveness of these educational methods.

Feedback also plays an integral role in both diagnosis education and performance. Several articles in this issue focus on how we can improve the process of diagnosis feedback. Goldowsky and colleagues apply the concept of self-regulated learning (SRL) – "the modulation of self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals" – to attain expert performance in diagnosis [12]. While this strategy has been written about in other aspects of skill development in medical education, it has not been investigated in the domain of clinical reasoning. The authors provide several specific examples of how to implement SRL clinical reasoning strategies in practice and different modalities of feedback and assessment. Rosner and colleagues elaborate further on how barriers to diagnostic feedback can be overcome, including strategies that can be implemented now – what they term "minimum viable product" approaches – and how we can move diagnostic feedback toward future "ideal state" solutions [13]. The authors highlight strategies to identify time points of readiness for feedback on diagnostic performance, encourage documentation of diagnostic specificity, include contextual factors in diagnostic performance reporting systems, integrate diagnostic uncertainty into diagnostic feedback, and promote and systematize information sharing. Both groups highlight the importance of technological advancements to move diagnosis feedback into the future such as simulation through virtual reality to provide a more contextualized simulation learning experience, artificial intelligence to individualize learning and feedback, and further advances in the use of the electronic health record (EHR).

Several articles highlight the tremendous technological advances made over the last decade and describe what is possible now in addition to where the future of technology in diagnosis is going. Building on the use of technology in diagnosis feedback, Schmidt and colleagues propose a novel use for digital decision support (DDS) modeled on deliberate practice and aligned with our understanding of the diagnostic process [14]. Traditional DDS tools generate a proposed differential diagnosis based on data provided. In their article, Schmidt and colleagues suggest clinicians alternatively report their diagnostic hypotheses while the DDS provides a list of discriminating and differentiating features in order to promote critical reflection on initial diagnostic hypotheses and consideration of alternative diagnoses. Both Miller and colleagues and Runyon and colleagues demonstrate the use of artificial intelligence to improve diagnosis [15, 16]. Miller and colleagues developed an unsupervised machine learning model, specifically detection of patterns in unlabeled datasets, to identify missed or delayed diagnostic opportunities. This technology has potential applications both prospectively in clinical decision support tools and retrospectively in review of diagnostic errors. Runyon and colleagues describe the development of a Natural Language Processing (NLP) computer-assisted scoring system called INCITE, the Intelligent Clinical Text Evaluator. INCITE was developed to assess clinical reasoning documentation in the now-discontinued USMLE Step 2 Clinical Skills examination. This technology has many advantages such as efficiency, consistency, and objectivity and has wide implications for assessment and feedback of clinical reasoning documentation.

We have come far in the last 20 years of studying diagnosis. We have gone from foundational studies describing the prevalence of diagnostic error and debating the role of cognitive bias in diagnostic error to identifying pragmatic strategies to improve diagnosis now and in the future. The future of diagnosis is bright, but we have our work cut out for us. The content featured in this special issue of *Diagnosis* provides readers with strategies to improve diagnosis, some that can be implemented immediately, and hopefully inspires the future work that will propel the field forward.

References

1. Holmboe ES, Durning SJ. Understanding the social in diagnosis and error: a family of theories known as situativity to better inform diagnosis and error. Diagnosis (Berl) 2020;7:161–4.
2. Merkebu J, Battistone M, McMains K, McOwen K, Witkop C, Konopasky A, et al. Situativity: a family of social cognitive theories for understanding clinical reasoning and diagnostic error. Diagnosis (Berl) 2020;7:169–76.
3. Olson A, Rencic J, Cosby K, Rusz D, Papa F, Croskerry P, et al. Competencies for improving diagnosis: an interprofessional framework for education and training in health care. Diagnosis (Berl) 2019;6:335–41.
4. Graber ML, Franklin N, Gordon R. Diagnostic error in internal medicine. Arch Intern Med 2005;165:1493–9.
5. Schiff GD, Hasan O, Kim S, Abrams R, Cosby K, Lambert BL, et al. Diagnostic error in medicine: analysis of 583 physician-reported errors. Arch Intern Med 2009;169:1881–7.
6. Singh H, Meyer AN, Thomas EJ. The frequency of diagnostic errors in outpatient care: estimations from three large observational studies involving US adult populations. BMJ Qual Saf 2014;23:727–31.
7. Linzer M, Sullivan E, Olson A, Khazen M, Mirica M, Schiff G. Improving diagnosis: adding context to cognition. Diagnosis (Berl) 2023;10:4–8.

8. Jagannath A, Driecer J, Penner J, Dhaliwal G. The cognitive apprenticeship: advancing reasoning education by thinking aloud. Diagnosis (Berl) 2023;10:9–12.
9. Santhosh L, Harris E, Moulder G. Teaching the science of uncertainty. Diagnosis (Berl) 2023;10:13–8.
10. Cook DA, Sherbino J, Durning S. Management reasoning: beyond the diagnosis. J Am Med Assoc 2018;319:2267–8.
11. Abdoler E, Parsons A, Wijeskera T. The future of teaching management reasoning: important questions and potential solutions. Diagnosis (Berl) 2023;10:19–23.
12. Goldowsky A, Rencic J. Self-Regulated learning and the future of diagnostic reasoning education. Diagnosis (Berl) 2023;10:24–30.
13. Rosner B, Zwaan L, Olson A. Imagining the future of diagnostic performance feedback. Diagnosis (Berl) 2023;10:31–7.
14. Schmidt H, Mamede S. Improving diagnostic decision support through deliberate reflection: a proposal. Diagnosis (Berl) 2023;10: 38–42.
15. Miller A, Arakkal A, Koeneman S, Cavanaugh J, Polgreen P. A clinically-guided unsupervised clustering approach to recommend symptoms of disease associated with diagnostic opportunities. Diagnosis (Berl) 2023; 10:43–53.
16. Runyon C, Harik P, Barone M. “Cephalgia” or “migraine”? Solving the headache of assessing clinical reasoning using natural language processing. Diagnosis (Berl) 2023;10:54–60.